NASA Leading Human Space Exploration

August 2018

Mack McElroy, PhD
NASA Locations

- Johnson Space Center
- Kennedy Space Center
- Ames Research Center
- Langley Research Center
- Marshall Space Flight Center
- Stennis Space Center
- Armstrong Flight Research Center
- Glenn Research Center
- NASA Headquarters
- Wallops Flight Facility
- White Sands Test Facility
- Jet Propulsion Laboratory
- Goddard Space Flight Center
- Johnson Space Center
- Kennedy Space Center
- Stennis Space Center
- Goddard Space Flight Center
- Wallops Flight Facility
NASA 2019 Projected Budget: $19.9 billion

Human Exploration and Operations - $10.5 Billion
Orion & Space Launch System
Commercial Crew
International Space Station

Science - $5.7 Billion
Mars Rover 2020
James Webb Space Telescope
Earth Science, Astrophysics, Heliophysics

Space Technology - $826 Million
Aeronautics Research - $656 Million

Safety, Security, Operations, Construction - $3.1 Billion

Education - $100 Million
Engineering Structures Division:
Systems Management on Major NASA Programs

- Space Shuttle
- Apollo Lunar Module
- Apollo Command and Service Module
- Apollo-Soyuz Test Project
- Skylab
- International Space Station
- Shuttle-Mir
- Orion
Exploration Campaign

Updated December 2017

2018
Transition U.S. human spaceflight in low-Earth orbit to commercial operations

2022
Extend long-duration U.S. human spaceflight operations to lunar orbit

2026

2030
Enable human exploration of the Moon to prepare for human missions to Mars
The Future of Human Space Exploration

NASA’s Building Blocks to Mars

Earth Reliant
Missions: 6 to 12 months
Return: hours

U.S. companies provide affordable access to low Earth orbit

Learning the fundamentals aboard the International Space Station
International Space Station

Began Construction: 1998
Purpose: Research
Future: Expanded commercial use

International Partners:
- Canada
- Russia
- Europe
- Japan

Boeing CST-100 Starliner
Planned 1st launch: 2018 (Nov.)
Max capacity: 7 crew

Space X Dragon Capsule
Planned 1st launch: 2018 (Dec.)
Max capacity: 7 crew

Commercial Crew
Refocus NASA Resources from Low Earth Orbit to Deep Space Exploration

- Commercial ISS Resupply: Space X, Orbital ATK
- Commercial crewed missions to ISS: Space X, Boeing
- Commercialization of ISS
The Future of Human Space Exploration

NASA’s Building Blocks to Mars

U.S. companies provide affordable access to low Earth orbit

Learning the fundamentals aboard the International Space Station

Missions: 6 to 12 months
Return: hours

Traveling beyond low Earth orbit with the Space Launch System rocket and Orion crew capsule

Missions: 1 month up to 12 months
Return: days

Earth Reliant

Proving Ground
Orion

- Human capsule (5 crew max.)
- Service module (propulsion & power)
- Led at Johnson Space Center
- First test flight: 2014
- First manned flight: 2023
Space Launch System

- Most powerful rocket to date
- Deep space missions
- Led at Marshall Space Flight Center
- First launch: 2019

Launch site: Kennedy Space Center
The Future of Human Space Exploration

**NASA’s Building Blocks to Mars**

**Earth Reliant**
- Learning the fundamentals aboard the International Space Station
  - Missions: 6 to 12 months
  - Return: hours

**Proving Ground**
- Exploring Mars and other deep space destinations
  - Missions: 1 month up to 12 months
  - Return: days

**Earth Independent**
- U.S. companies provide affordable access to low Earth orbit
- Traveling beyond low Earth orbit with the Space Launch System rocket and Orion crew capsule
  - Missions: 2 to 3 years
  - Return: months

Expanding capabilities by visiting an asteroid in a Lunar distant retrograde orbit
Was Mars home to microbial life? Is it today?

Could it be a safe home for humans one day?

What can it teach us about life elsewhere in the cosmos or how life began on Earth?

What can it teach us about Earth's past, present and future?
Return to the Moon

- Lunar Orbital Platform (Gateway)
- Infrastructure for long term Moon presence
- Robotic >> human
- Drive activity with commercial and international partners
  - Develop human deep space exploration capabilities
    - Enabled by SLS and Orion

**Orbiting Lunar Platform**

**Orion**

**PHASE 1**
# Deep Space Gateway

<table>
<thead>
<tr>
<th>EM-1</th>
<th>Europa Clipper</th>
<th>EM-2</th>
<th>EM-3</th>
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<td><strong>SLS Block 1</strong></td>
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<td><strong>Distant Retrograde</strong></td>
<td><strong>Europa Clipper (subject to approval)</strong></td>
<td><strong>Multi-TLI Lunar Free Return</strong></td>
<td><strong>Near Rectilinear Halo Orbit (NRHO)</strong></td>
<td><strong>NRHO, w/ ability to translate to/from other cislunar orbits</strong></td>
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<td><em>26-40 days</em></td>
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**Deep Space Gateway Buildup**

- **2019 - 2025**
  - SLS Block 1B Power/Prop Bus: 40kW
  - Europa Clipper Capability: 8-9T
  - Multi-TLI Lunar Free Return Capability: 8-21 days
  - Near Rectilinear Halo Orbit Capability: 16-26 days

- **2026**
  - Logistics Capability: 10mT
  - Airlock Capability: 10mT

**Gateway (blue) Configuration (Orion in grey)**

- Cislunar Support Flight
- Cislunar Support Flight
Deep Space Transport

- Larger long duration habitat
- Reusable

PHASE 2

Deep Space Gateway (DSG) Concept

Orion

Deep Space Transport (DST) Concept
# Mars Transit

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<th>Transport Delivery</th>
<th>Transport Shakedown</th>
<th>Mars Transit</th>
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Orion Exploration Mission 1 (EM-1)

- Un-crewed mission around the moon
- Launch date: June 2020
Orion: A Journey around the Moon Powered by Airbus’ ESM

While travelling around the Moon and back on its first mission (EM-1), the unmanned NASA Orion spacecraft will demonstrate its systems and high speed entry performance prior to crewed flights. Under an ESA contract, Airbus Defence and Space is building the European Service Module (ESM) that will power the spacecraft and hence provide critical functions during the whole mission.
Orion Fabrication
(Thermal Tiles Installed)
Integration
Testing
Re-entry
Recovery
Questions?

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